MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

RESEARCH ACTIVITIES AT INPE USING GPS RECEIVERS

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INPE- São José dos Campos São Paulo

OUTLINE

-GPS RECEIVERS LOCATION OVER BRAZIL

-IONOSPHERIC EFFECTS OVER GPS SIGNAL

EQUATORIAL IONOSPHERIC ANOMAY

IONOSPHERIC IRREGULARITIES (BUBBLES)

-MAGNETIC STORM EFFECTS OVER TEC

-FUTURE PLANS

IONOSPHERIC MODEL DEVELOPMENT (RESEARCH AND NAVIGATION)

REAL TIME SCINTILLATION ARRAY

-CESAR VALLADARES (BC) LISN PROJECT

NSF receivers (C. Valladares)

Ji-Paraná
Porto Velho
Rio Branco
Parintins
Tefé
Boa Vista
Campo Grande
Dourados
Cuiabá
Santarém
Alta Floresta

SCINTMON GPS RECEIVERS SITES OVER BRAZIL

- DEVELOPED AT CORNELL UNIVERSITY FROM A GEC PLESSEY GPS BUILDER-2 CARD

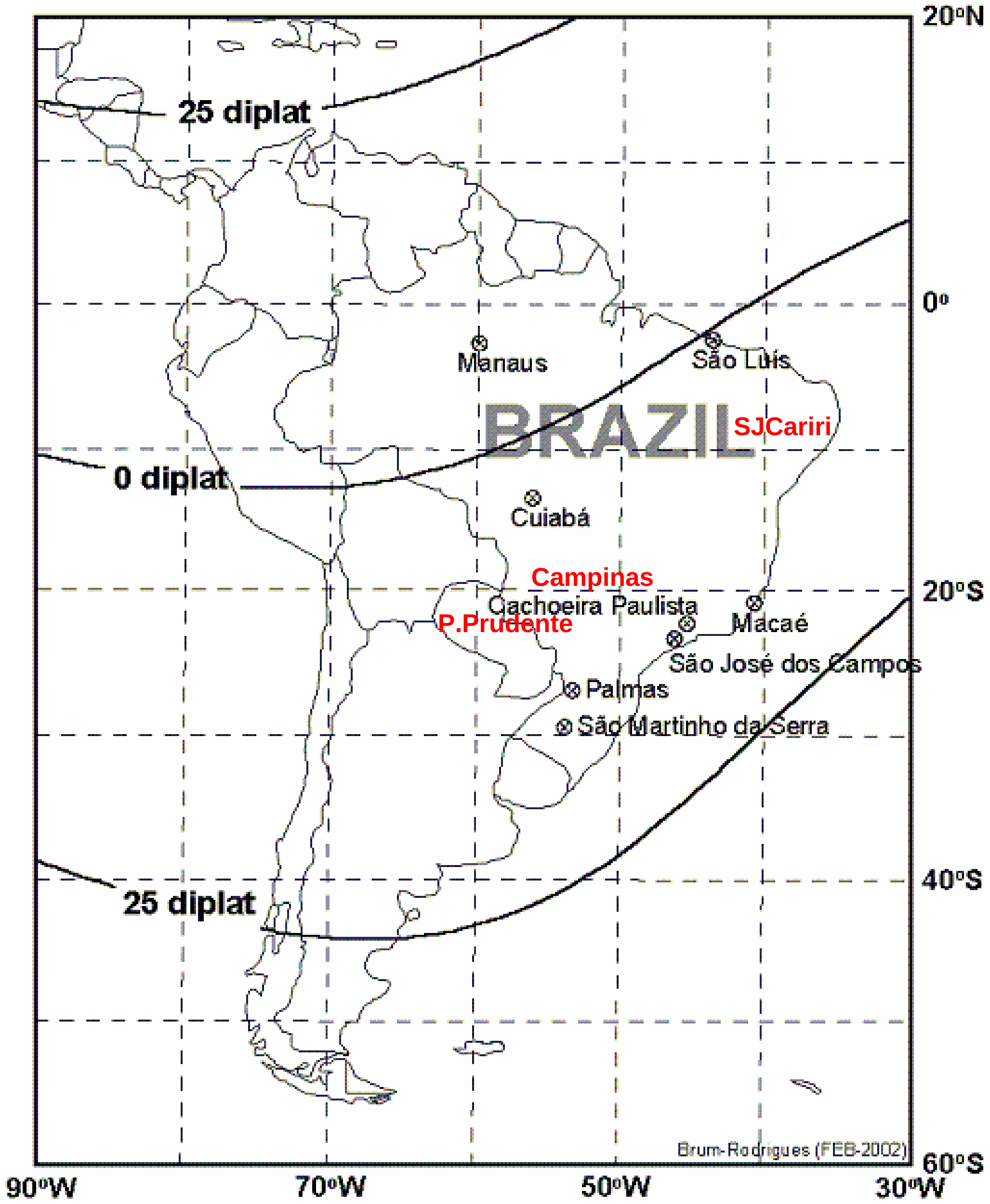
- IT RECEIVES IN THE L1 BAND (1.575 GHz)

- 12 CHANNELS (ONE IS NOISE)

- HAS THE ABILITY TO TRACK SIMULTANEOUSLY UP TO 11 SATELLITES

- THE SAMPLE RATE IS 50 Hz (50 SAMPLES/SEC)

- ELEVATION MASK 10^0



THE EFFECTS OF THE IONOSPHERIC TOTAL ELECTRON CONTENT (TEC) OVER GPS SIGNAL

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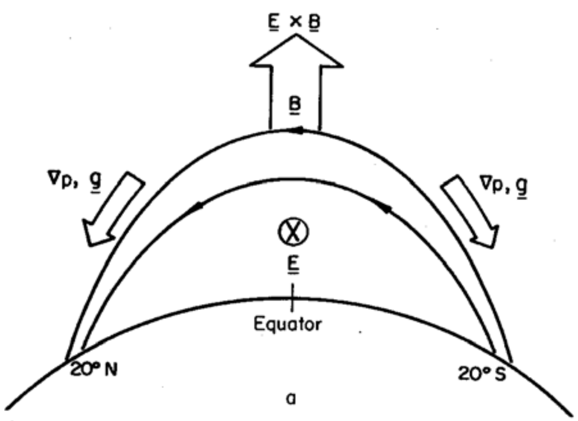
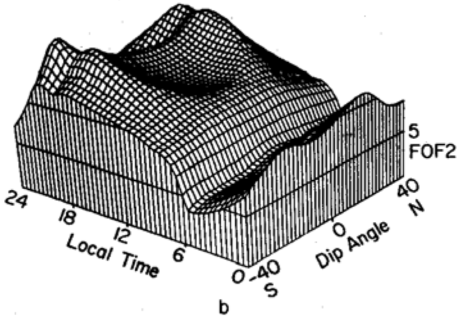
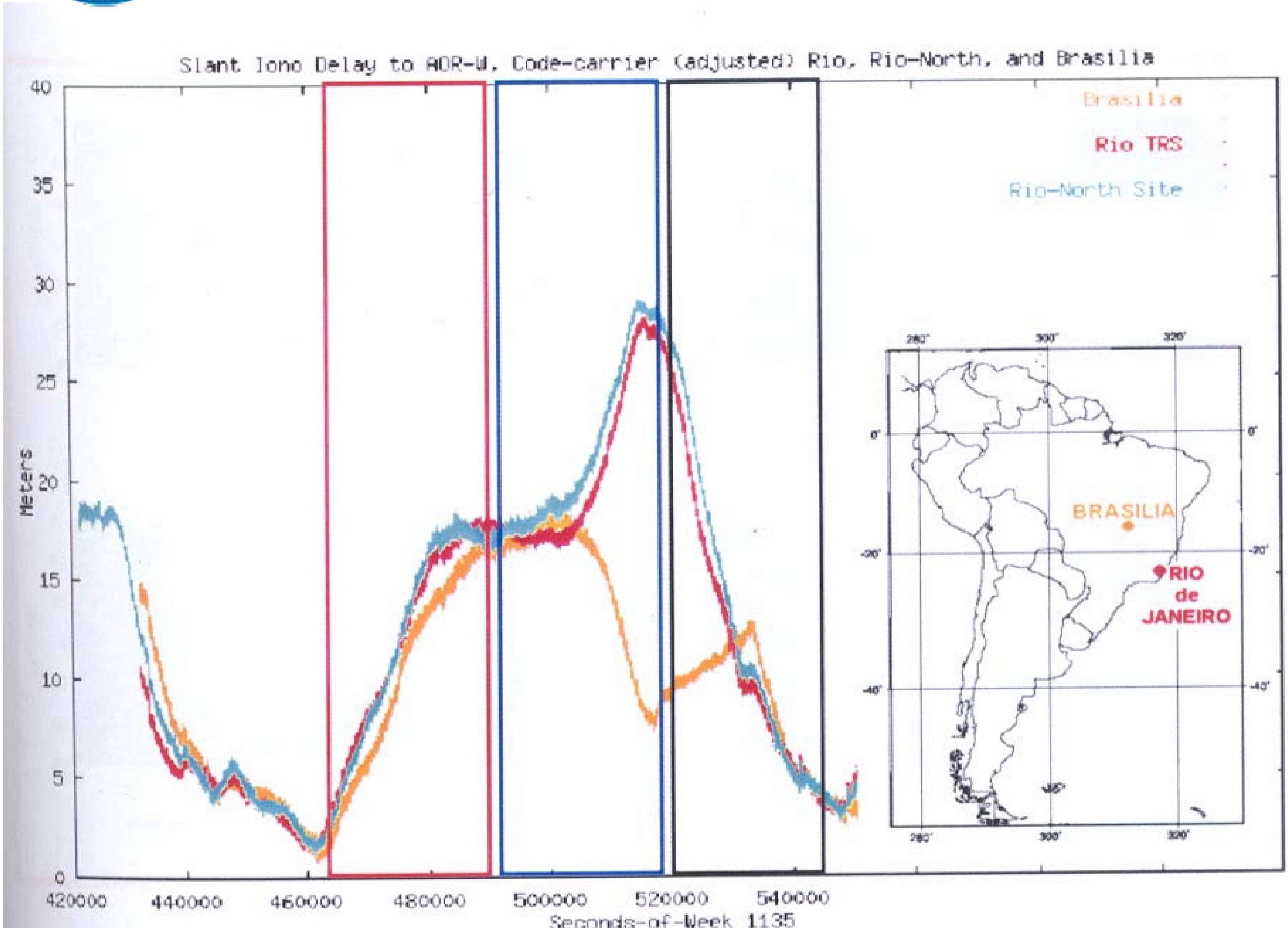


- THIS IONOSPHERIC DELAY IS PROPORTIONAL TO THE TOTAL ELECTRON CONTENT ALONG THE GPS SIGNAL.

- **OVER LOW MAGNETIC LATITUDES (BRAZIL FOR EXAMPLE) THE IONOSPHERE PRESENTS THE EQUATORIAL IONOSPHERIC ANOMALY THAT CONSTITUTES OF HIGHER ELECTRON DENSITIES PEAKS AT ABOUT 15 MAGNETIC DEGREES (NORTH AND SOUTH) COMPARED TO EQUATORIAL REGION.**

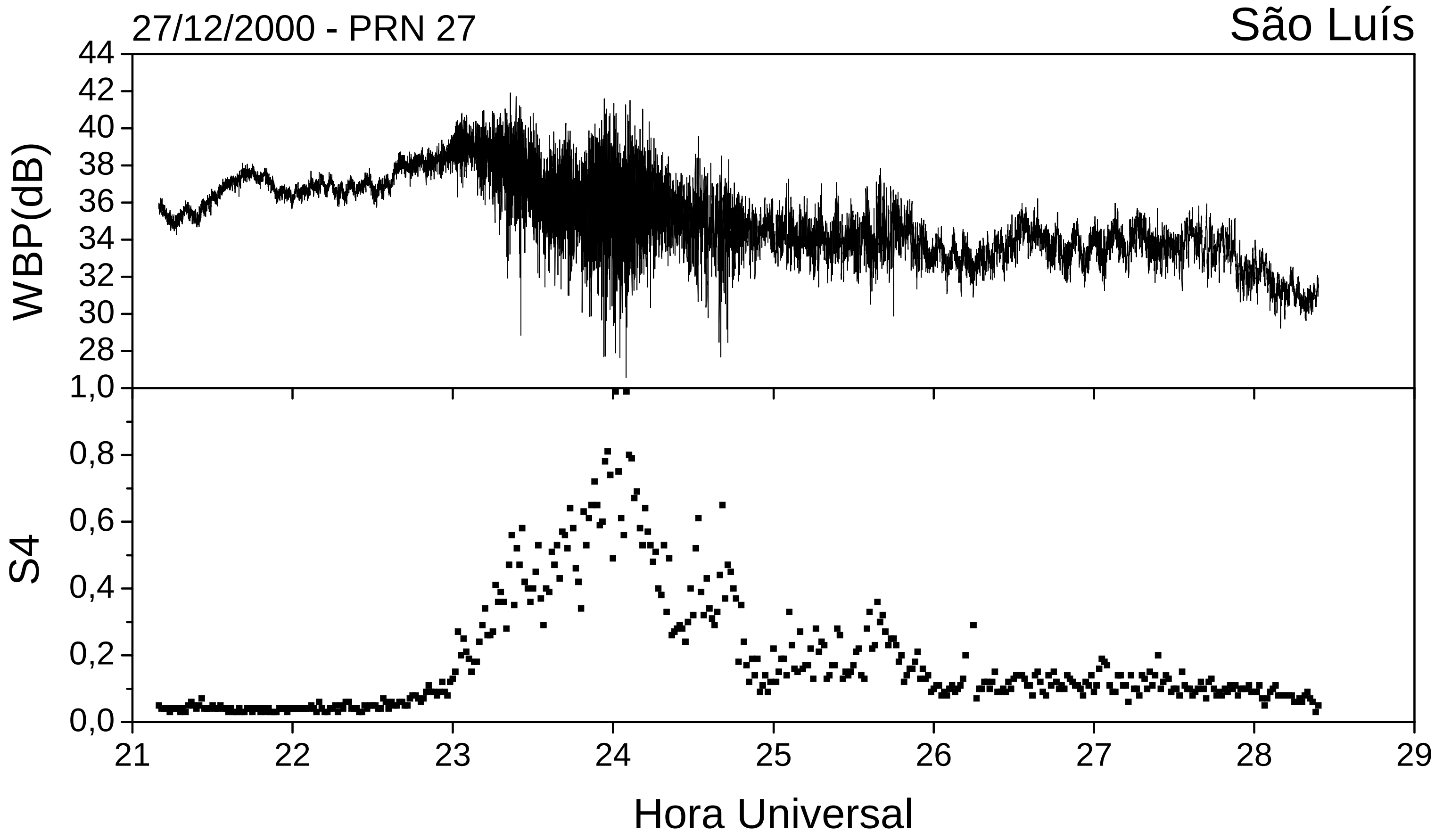


THE EFFECTS OF THE EQUATORIAL IONOSPHERIC ANOMALY OVER OVER GPS SIGNAL



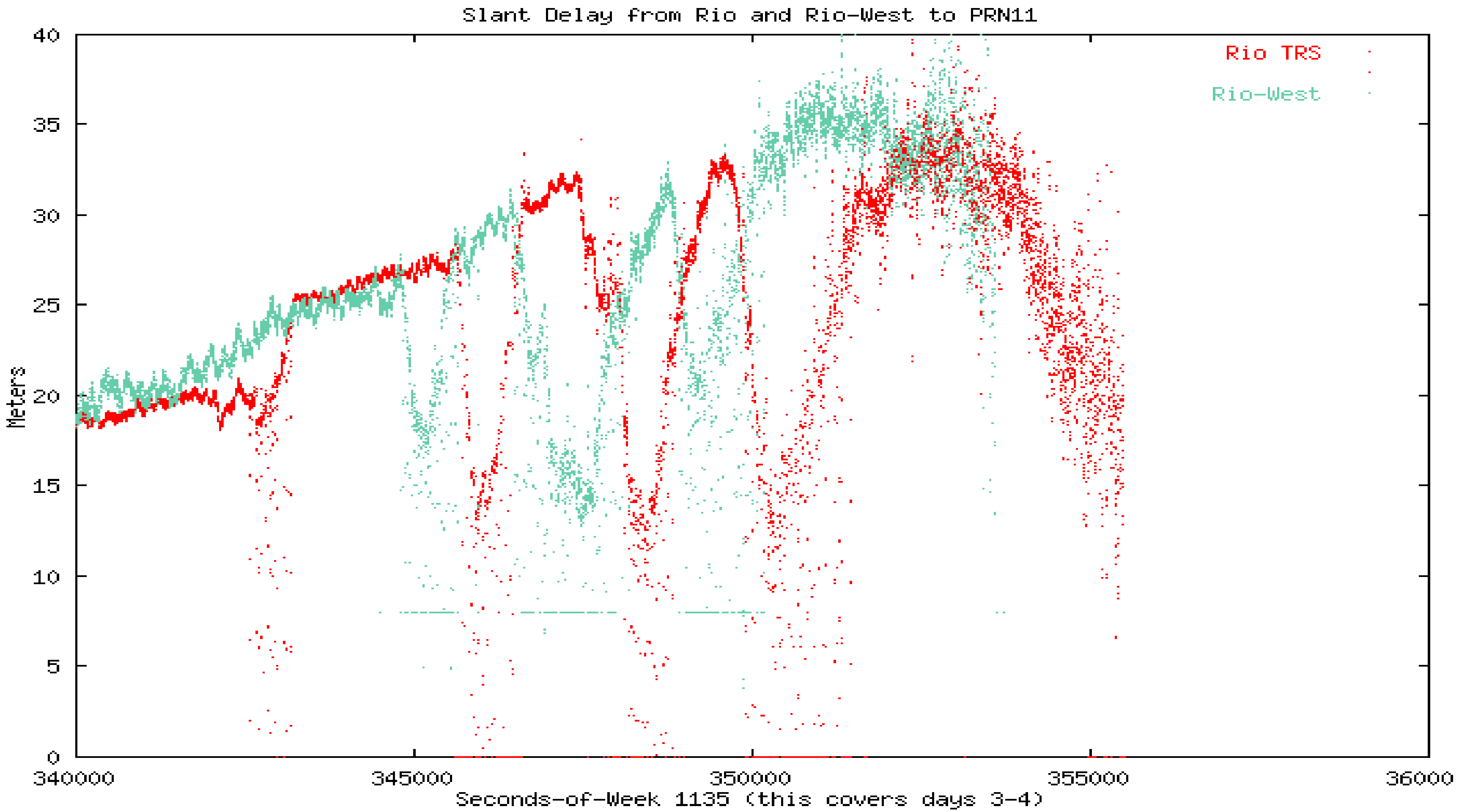
IONOSPHERIC IRREGULARITIES EFFECTS OVER GPS SIGNAL

IONOSPHERIC SCINTILLATIONS



THE EFFECTS OF IONOSPHERIC IRREGULARITIES OVER TEC

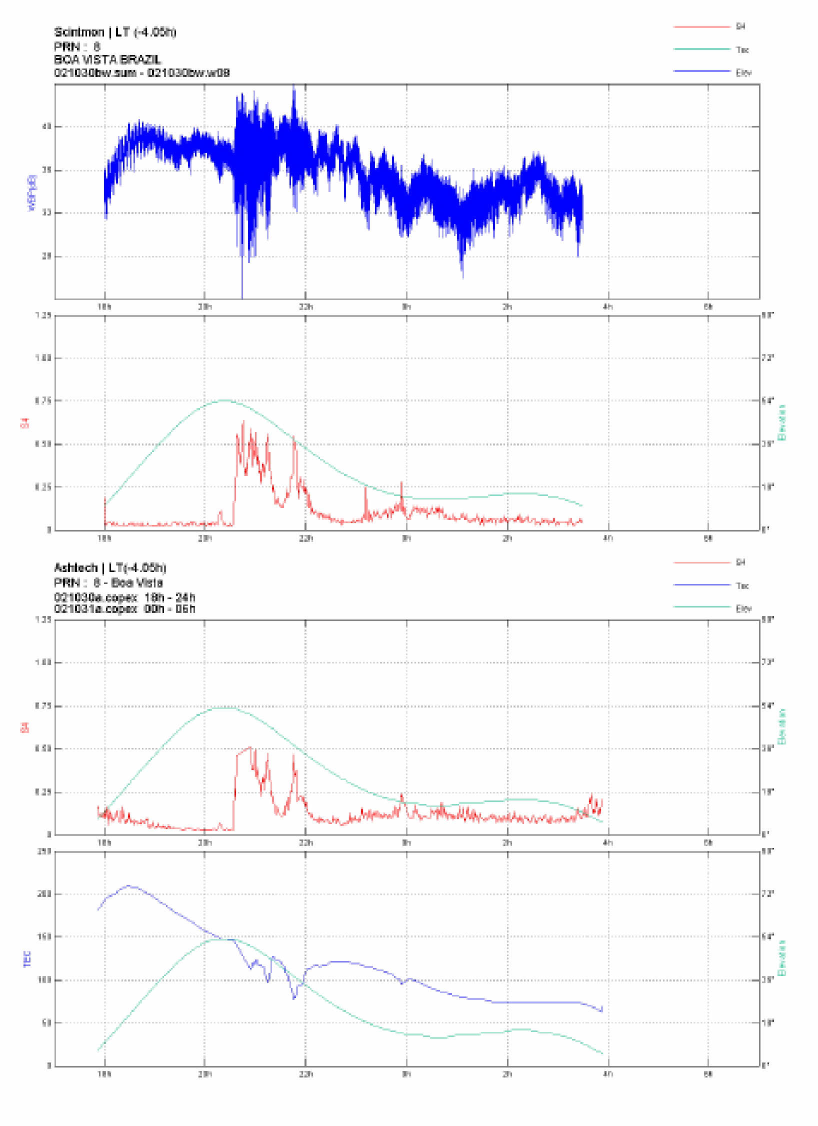
- **IONOSPHERIC IRREGULARITIES CAUSE LARGE DEPLETIONS ON THE TOTAL ELECTRON CONTENT AFFECTING THE SLANT DELAY**



PLOT FROM TOM DEHEL (FAA – FEDERAL AVIATION ADMINISTRATION – USA), 2002

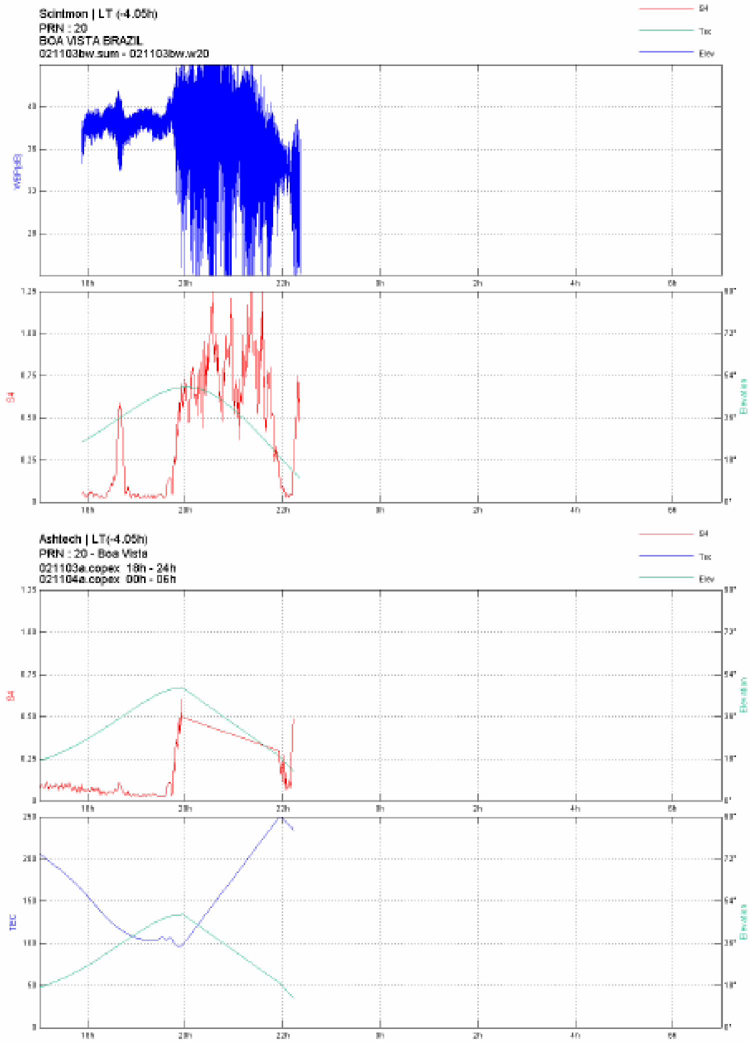
IONOSPHERIC IRREGULARITIES EFFECTS OVER GPS SIGNAL

TEC FLUCTUATIONS



IONOSPHERIC IRREGULARITIES EFFECTS OVER GPS SIGNAL

LOSS OF LOCK – INTERVAL WITHOUT TEC



IONOSPHERIC IRREGULARITIES EFFECTS OVER GPS SIGNAL

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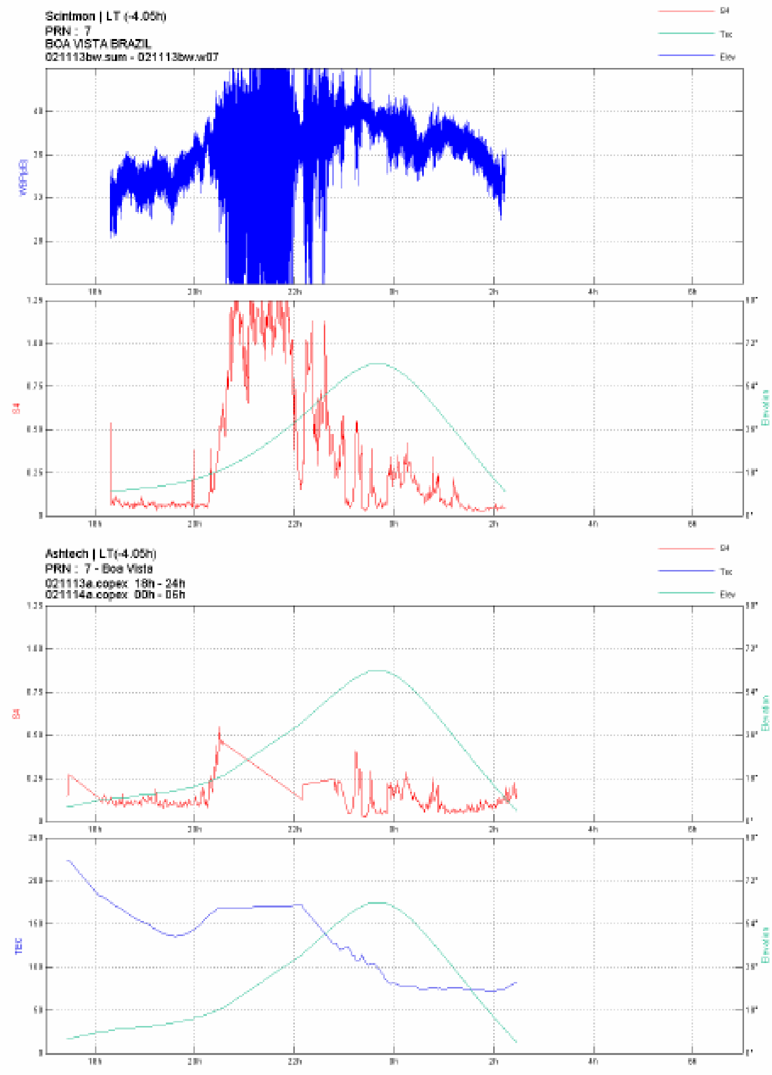


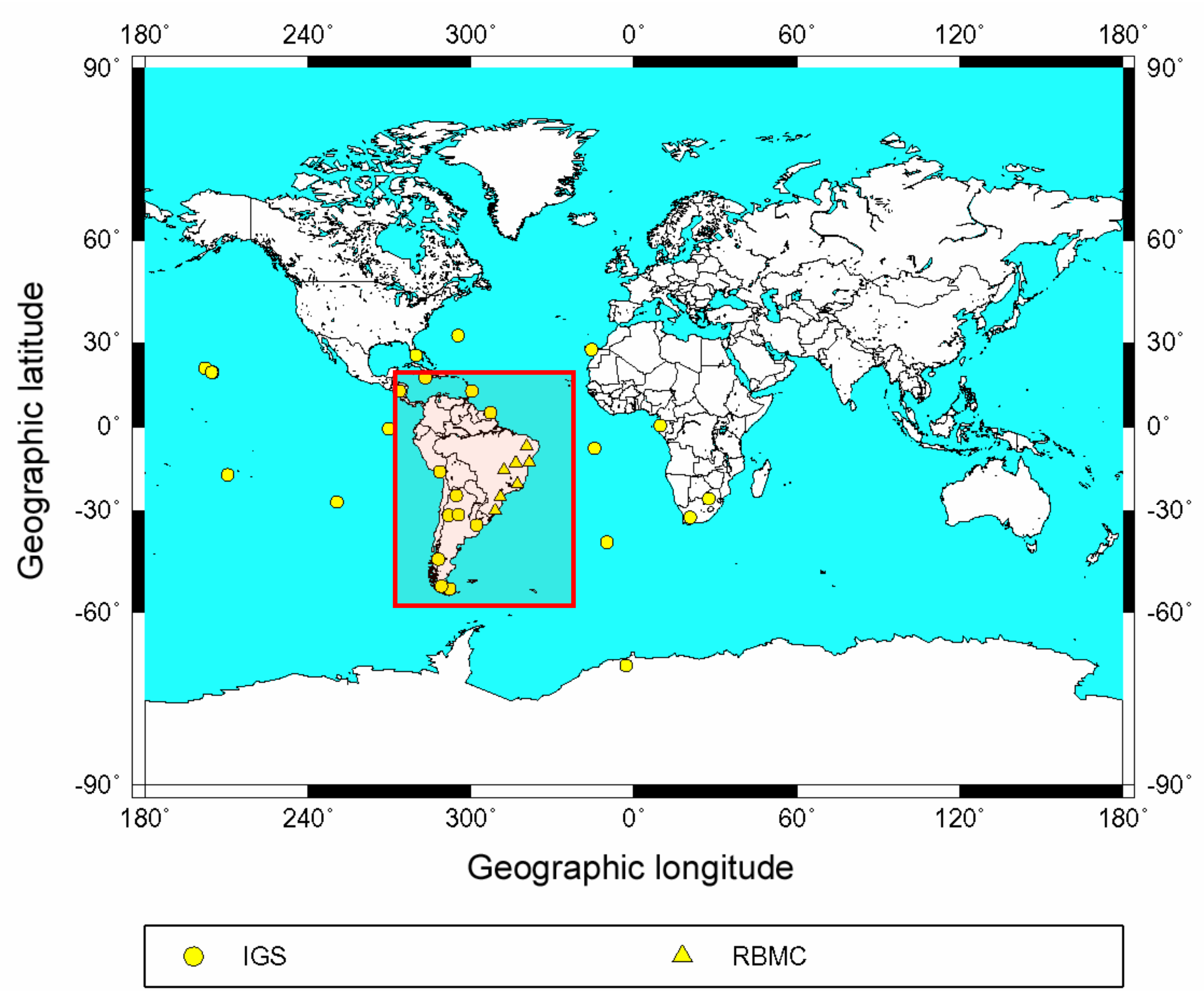
MAGNETIC STORM EFFECTS OVER TEC

-THE NEXT FEW SLIDES WILL SHOW SOME EFFECTS OF THE MAGNETIC STORMS OVER TEC

ONE EFFECT IS THE EQUATORIAL IONOSPHERIC ANOMALY (EIA) EXPANSION AND TEC PEAKS CAN REACH SOUTHERN LATITUDES LIKE ARGENTINA AND AT USA REACHING NEW YORK AND CALIFORNIA

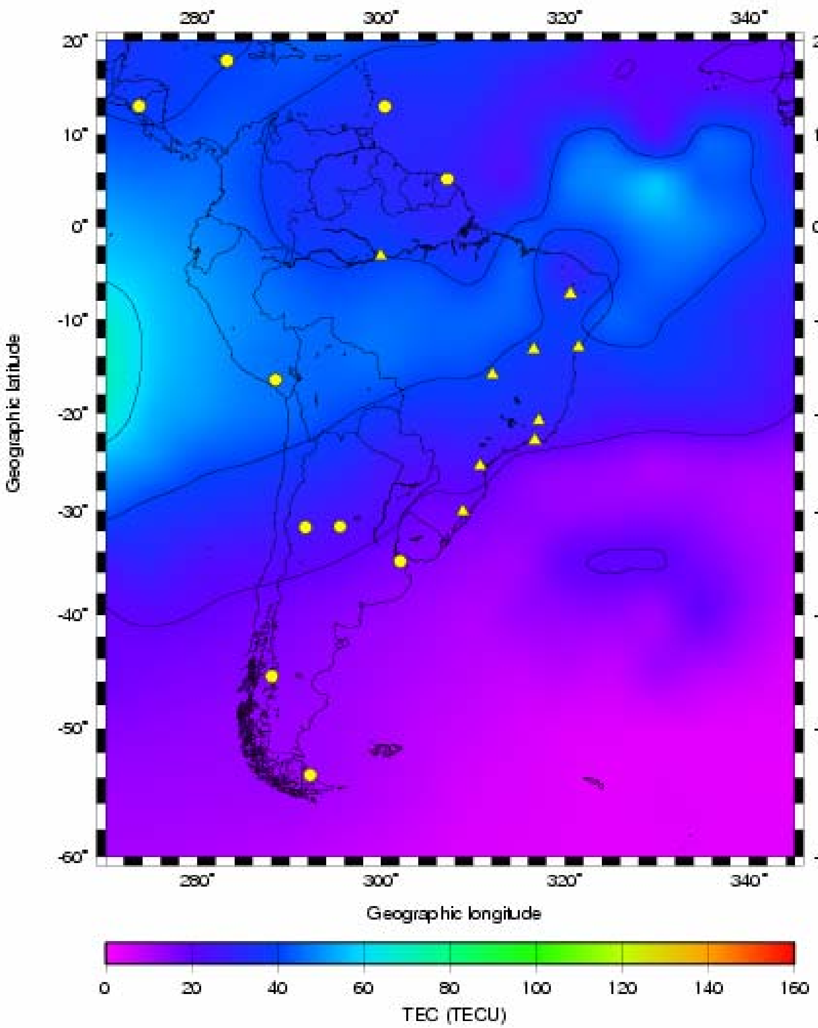
THE STORM SOMETIMES CAN INHIBITE THE EIA

GPS Stations Used in the Data Processing



Day 195, 2000 - 22:00 UT

(18:00 LT at 300°E)



Day 197, 2000 - 22:00 UT

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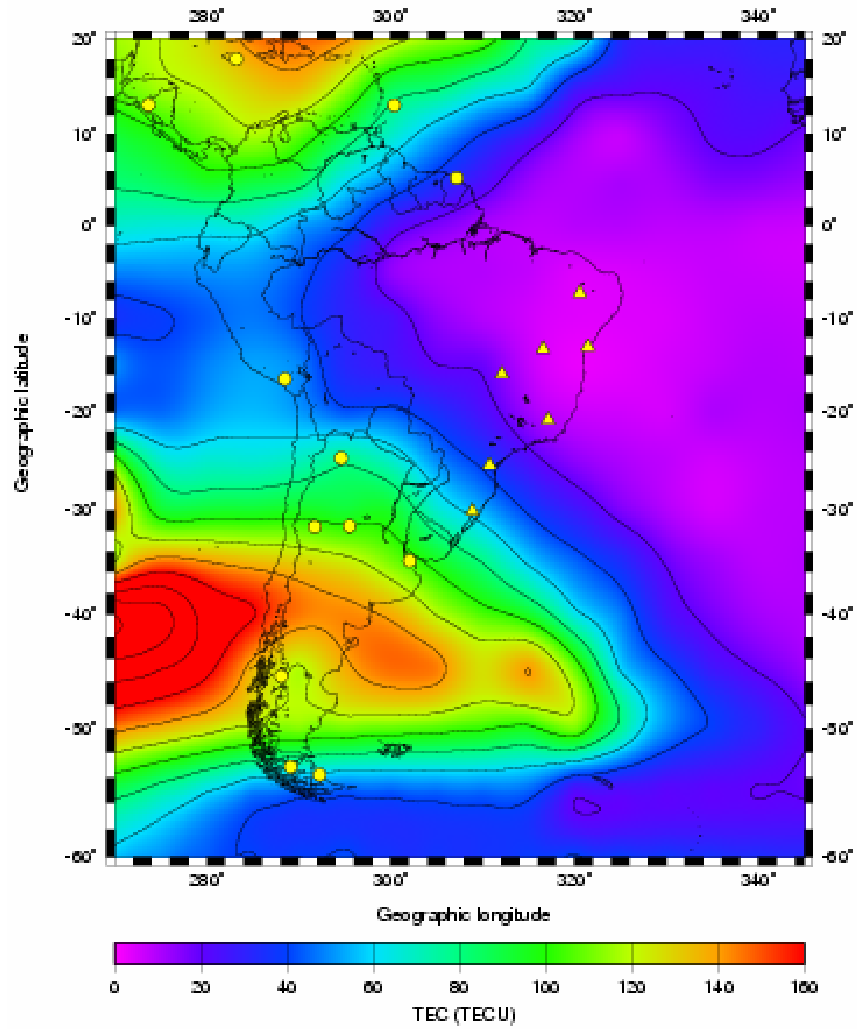
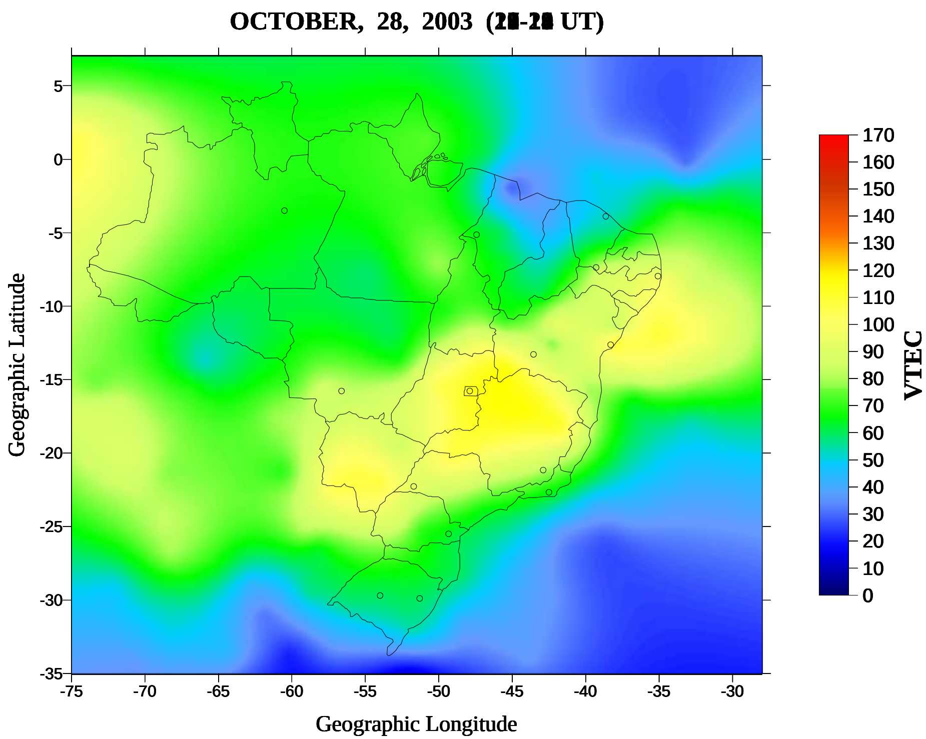
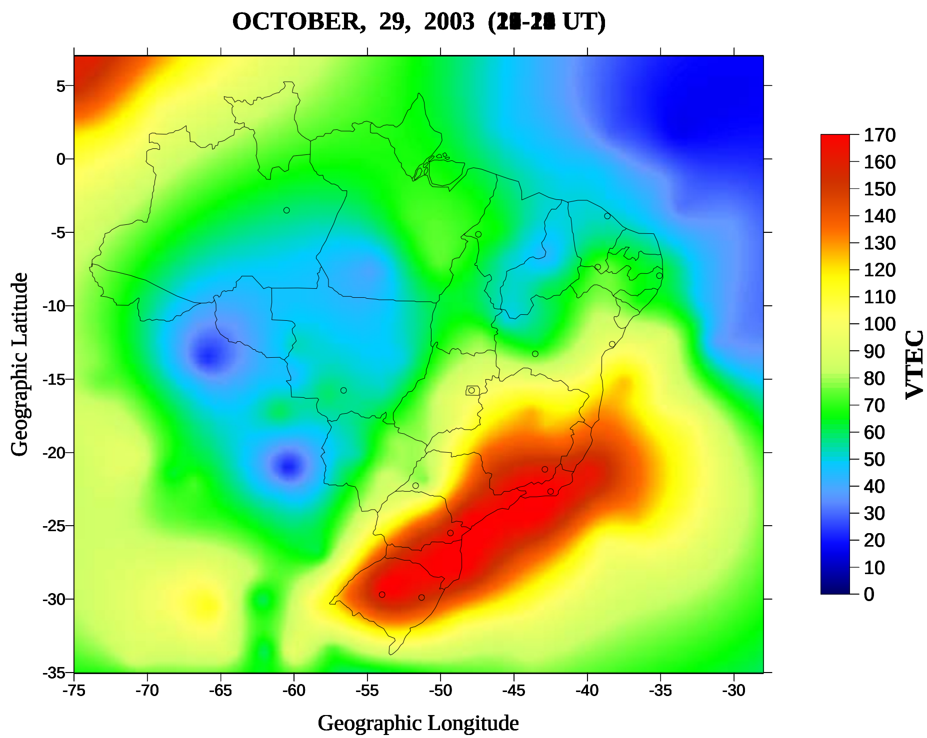


TOTAL ELECTRON CONTENT (TEC) DURING OCT 28 (WEAKLY DISTURBED) AND OCT 29 (DISTURBED), 2003





These plots were provided by Marcelo T. Matsuoka and Paulo O. Camargo from UNESP – Presidente Prudente, São Paulo

IONOSPHERIC MODEL FOR BRAZIL

IN THE NEAR FUTURE WE INTEND TO DEVELOP AN IONOSPHERIC MODEL USING IBGE DATA FOR NAVIGATION (SBAS)AND OTHERS APPLICATIONS

FOR THIS FINALITY WE NEED TO:

- -DETERMINE THE ABSOLUTE TEC CONSIDERING CYCLE SLIPS, INSTRUMENTATIONS BIAS, DATA QUALITY, ETC.

WHICH IS THE BEST MODEL TO USE? (BERNESE, UNB,..)

IN THE NEAR FUTURE WE INTEND ALSO TO HAVE REAL TIME SCINTILLATIONS OVER BRAZILIAN TERRITORY USING GPS RECEIVERS WITH LINUX

The LISN Distributed Observatory: The Deployment Phase

Cesar E. Valladares, Boston College
Jorge L. Chau, JRO
Vince Eccles, Space Environment Corp.
Erhan Kudeki, Univ. Illinois
Ronald F. Woodman, IGP

Presented by:

Objectives

- **To build and install the first Distributed Observatory across the western half of South America. Provide real-time display of observables.**

By using assimilation:

- **To study the electrodynamics of the low-latitude ionosphere during magnetic quiet and disturbed conditions.**

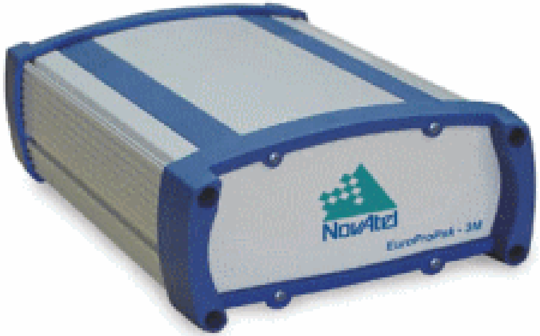
- **To develop tools to help forecast the initiation of equatorial spread-F (ESF) in a regional basis.**

A distributed observatory to address aeronomy and space weather problems that will have a standard mode of operation, but at the same time special and campaign modes.

GPS selected for the LISN network

GPS
Ionospheric
Scintillation and Tec
Monitor GSV4004B

- SBAS capable (amplitude and phase).
- Tracks 10 GPS satellites and 3 SBAS.
- 50 Hz amplitude and phase measurement for scintillations.
- Stable ovenized crystal oscillator.

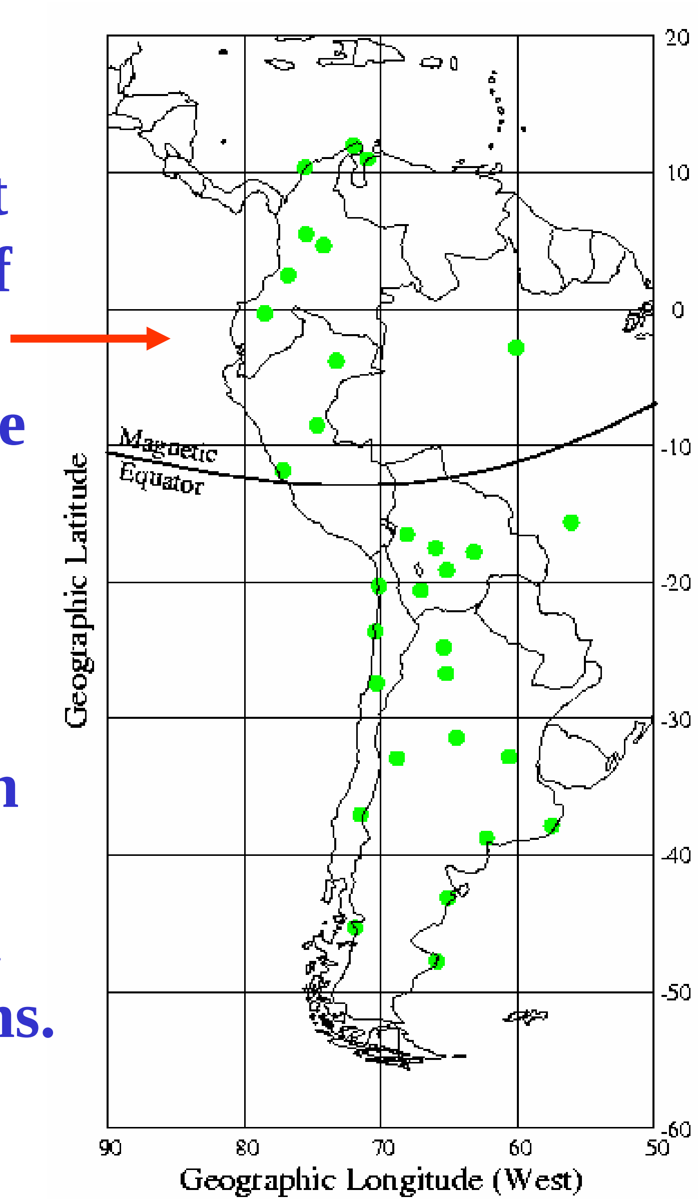


GSV4004B GPS IONOSPHERIC SCINTILLATION AND TEC MONITOR WITH

Existent GPS receivers in SA

Operating GPS receivers in SA that may become part of the LISN network. Their infrastructure is being upgraded.

All these receivers (30) will give TEC in real-time basis. In addition, 17 of them will give scintillations.

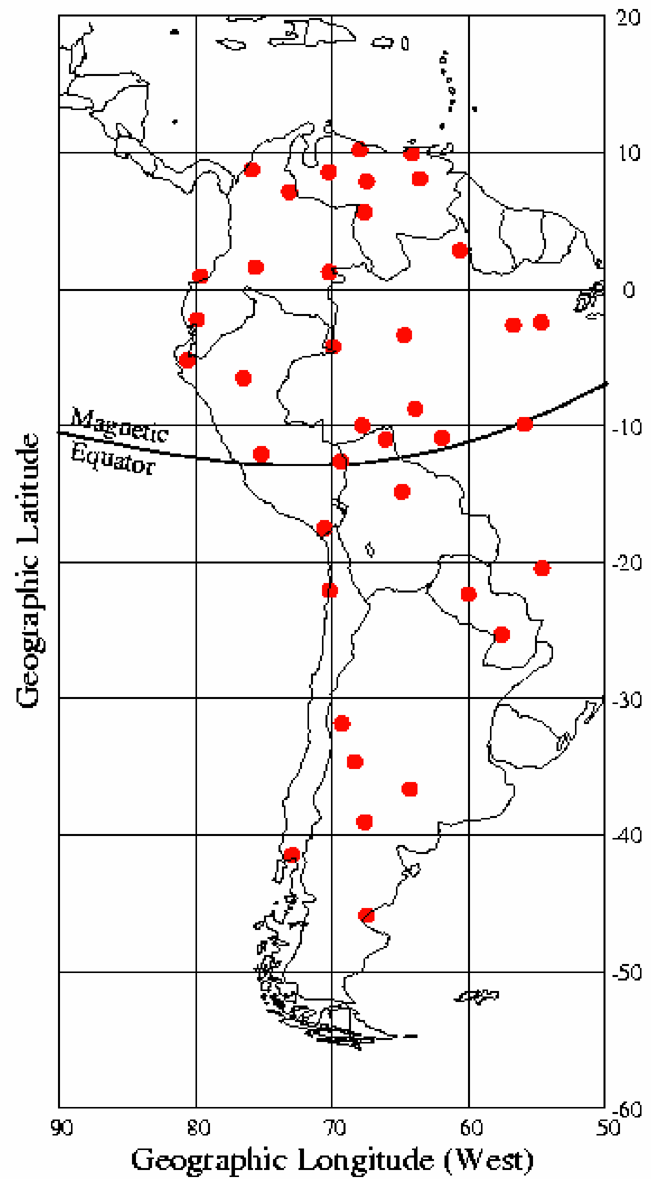


Receivers belong to BC(6), Mike Bevis OSU (9), Claudio Brunini UNLP (7), Victor Rios UT, Bob Smalley UM (2), K. Groves AF (2), Hector Mora INGEOMINAS (2), NGA (1), Yogesh Sahai UNIVAP (1).

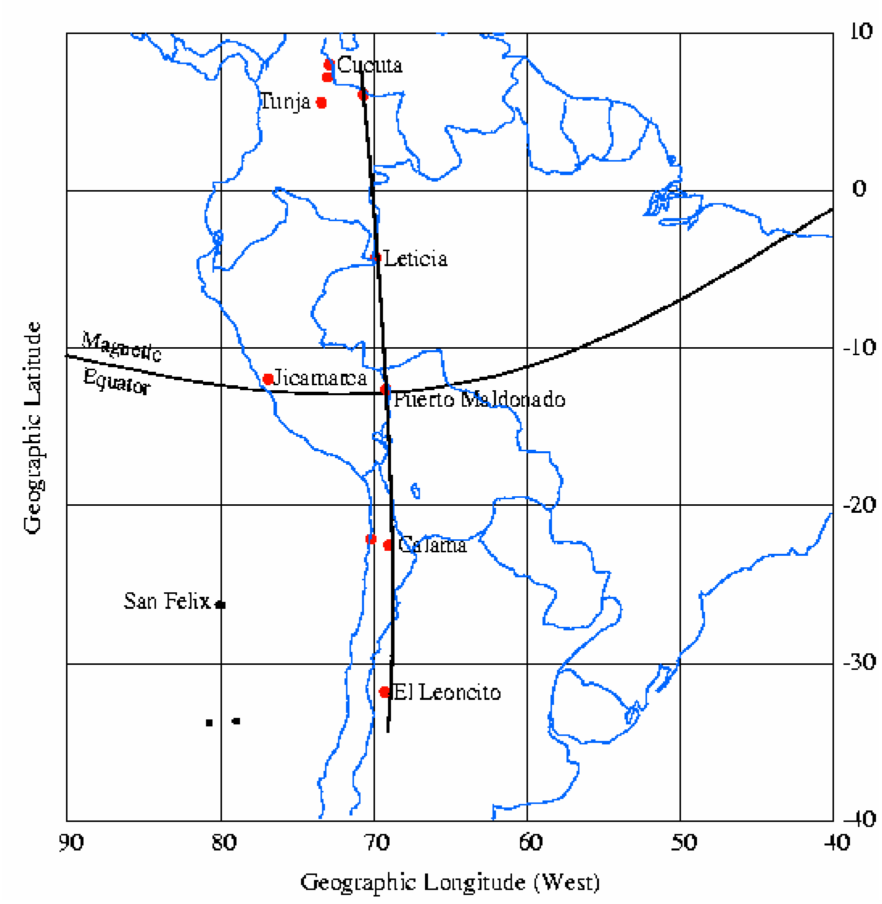
LISN GPS receivers to be installed

Installation to be conducted under the collaboration of (agreements signed with):

Dr. J. Chau, JRO, Peru
Dr. C. Brunini UNLP, Argentina
Dr. E. DePaula, INPE, Brazil
Dr. J. Villalobos, UNC, Colombia
Dr. H. Mora, INGEOMINAS, Colombia.
Dr. J. Araya, UCN, Chile.
Dr. A. Tierra, EPE, Ecuador.



5 dynasondes to be placed at El Leoncito, Carmen Alto, Puerto Maldonado, Leticia & northern Colombia

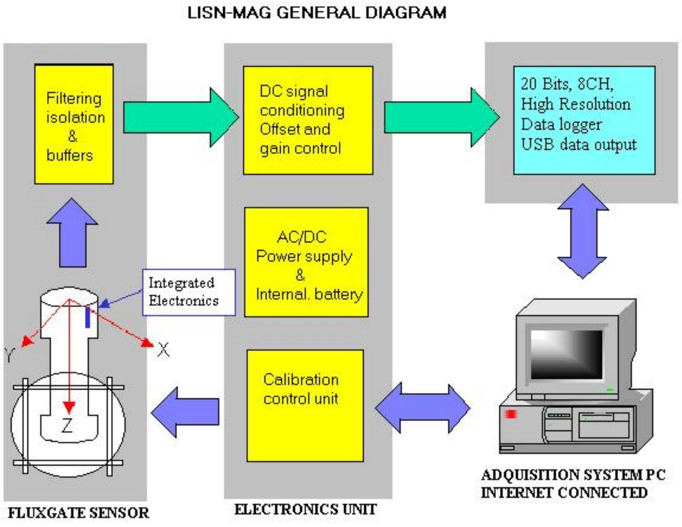


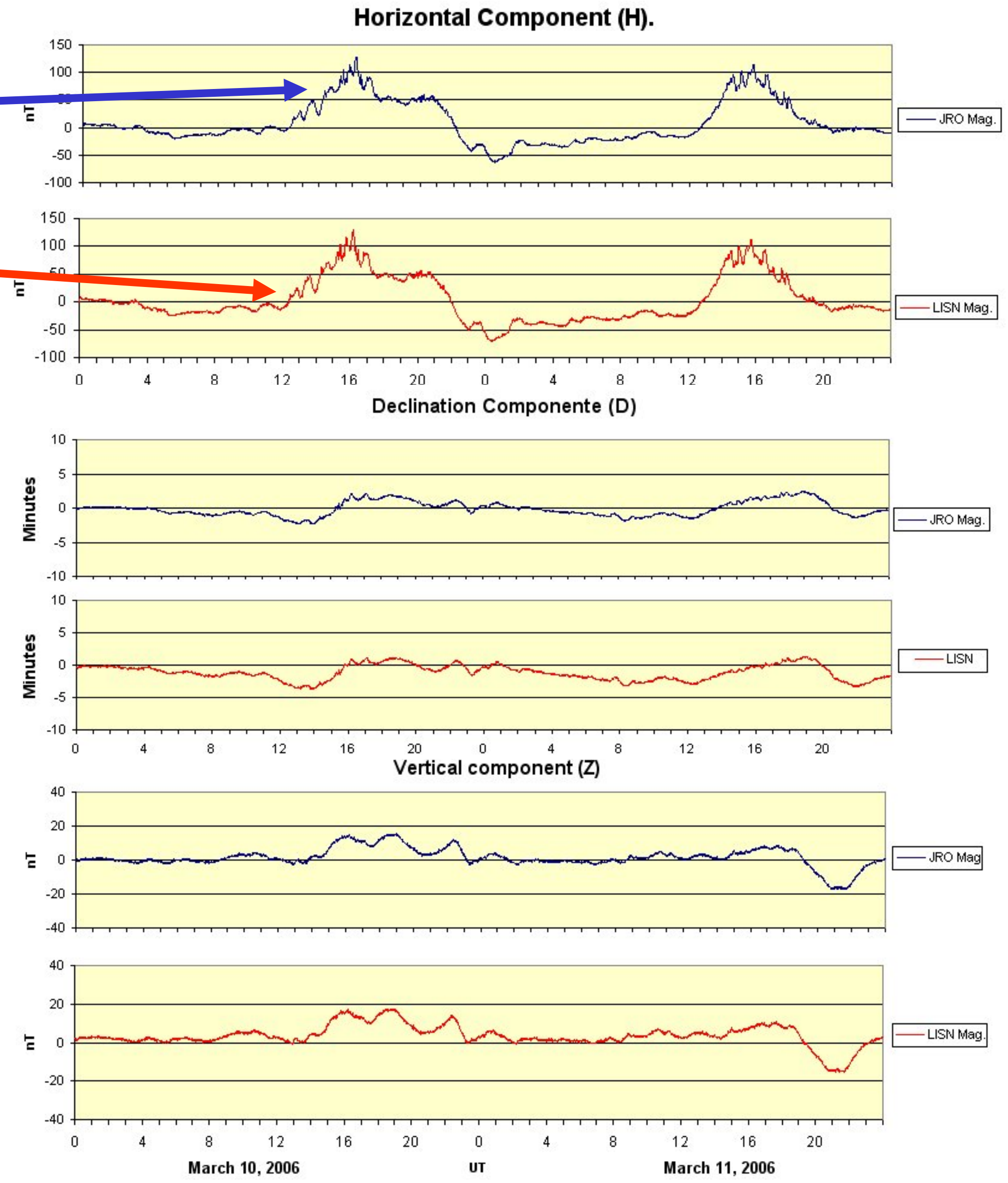
5 Dynasondes designed by Terry Bullett, Bob Livingstone (hardware) and Bill Wright (software).

1. High-frequency radar hardware system.
   Eight receiver channels.
   Eight active antenna preamplifiers.
   Real-time control/data acquisition PC.
   GPS timing module for bistatic operation.
   Linux O/S with radar control interface.
2. Transmitter power amplifier, Tomco.
   Four KW
3. Receiver dipole array with eight non-resonant dipole antennas.

Development of a prototype magnetometer

Comparison of UCLA magnetometer and new Jicamarca (LISN) prototype.





Magnetometer Design by Oscar Veliz

LISN Web Page
http://jro.igp.gob.pe/subwebs/lisn/

LOW-LATITUDE IONOSPHERIC SENSOR NETWORK

Home | About LISN | Equipment | Stations | Other

Telecommunications play an important role in science and technology world-wide. This field has its own phenomena that need to be explained, and that is the challenge for LISN.

LISN, as a permanent array of the newest geophysical instruments in South America, closely coordinate as a "distributed observatory". Our main focus is on complex and extreme state of disturbance that take place in the magnetical-equatorial ionosphere nearly every day after sunset, and on the ionosphere-thermosphere-electrodynamics (ITE) system than constantly controls the dynamics of the plasma density, creating the proper conditions to initiate plasma turbulence.

Known and studied for seven decades, the equatorial Spread F (ESF) phenomena are now held responsible for causing high-technology (GPS) navigation and communication failures that depend on inter-hemispheric link. Enough is known and understood about this region and its process to show conclusively that nothing less than a meteorological approach to detailed and comprehensive observations, integrated closely with assimilative modeling, can lead to physical understanding and the imperatives of practical forecasting and nowcasting.

Stations

All Stations

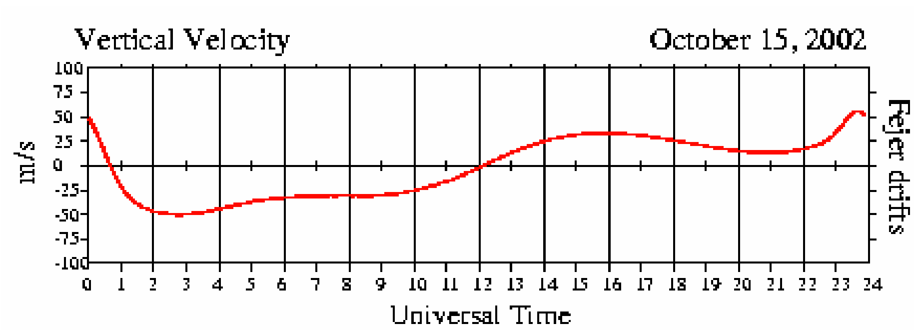
Peru	Argentina	Bolivia
Brazil	Chile	Colombia
Ecuador	Paraguay	Venezuela

Science Uniting the Americas

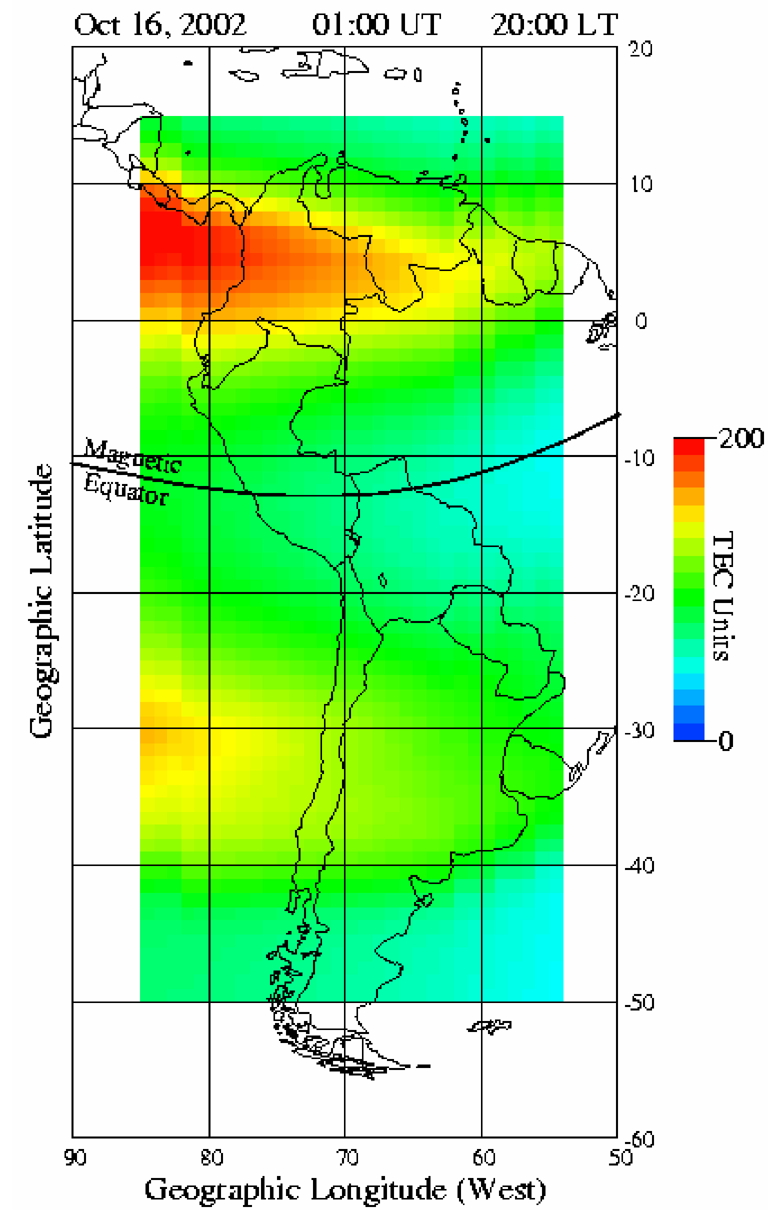
Username: userlisn

Simulation of the LISN TEC display

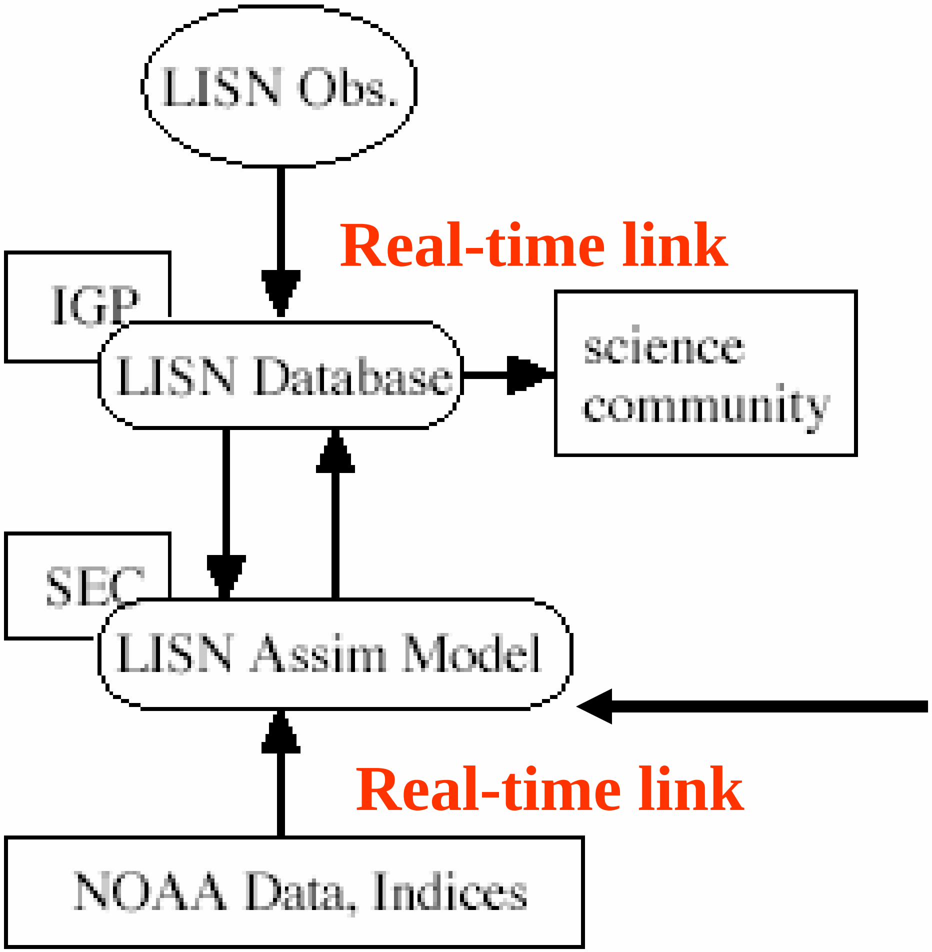
Fejer's drifts multiplied by a factor dependent on longitude. 1.3 at 85°W and 0.7 at 55°W.



Constant meridional wind equal to +60 m/s (northward)

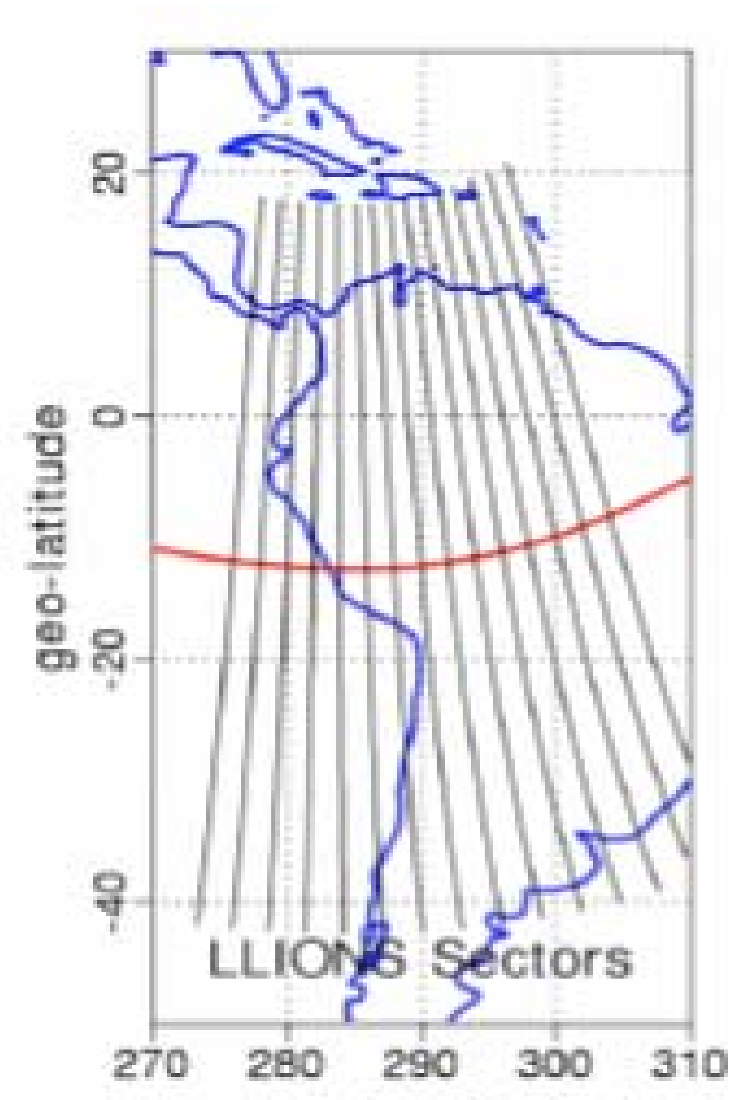


Real-time data flows of LISN data and assimilation



(1) Low-latitude Ionospheric model, (2) low-latitude electrodynamics model, (3) model of ground-based magnetic perturbations for a 3-D current system (4) Kalman filter program.

A Complementary Aspect of LISN



The LISN project includes an assimilative physics-based model designed to “nowcast” the ionosphere above the same geographic region. The model will use a Kalman filtering technique to assimilate the data and the LLIONS model developed by SEC.

Jicamarca will be used to validate results, but also its data will be later assimilated into the assimilation string

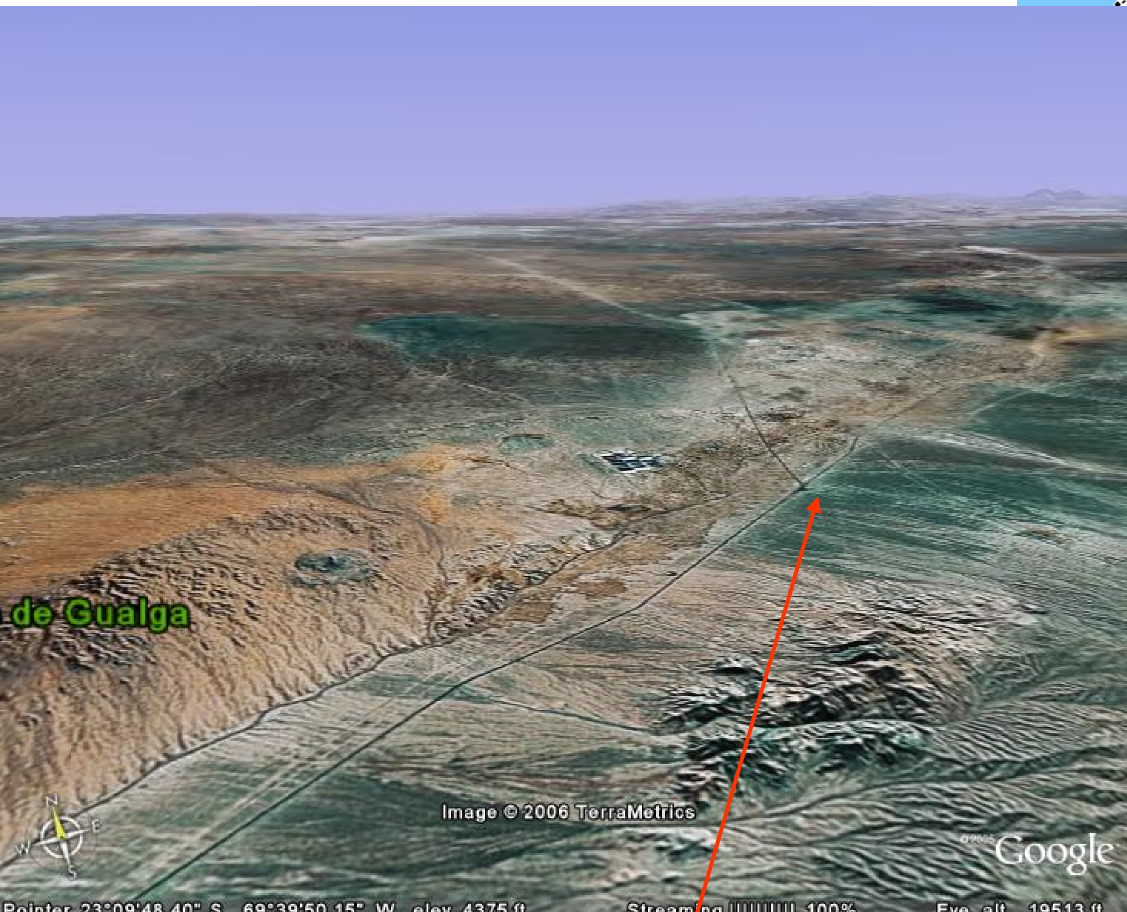
We can use the high altitude resolution of the Jicamarca meas. to extend this resolution along a meridian. Ingest Jicamarca temperatures.

Concluding Remarks

- I want to invite other members of the SIRGAS community, who have instruments in South America to be part of LISN. A SuperLISN?
- This program is supported by the National Science Foundation to initiate collaboration with universities and research institutes from South America.

Leticia Site

Carmen Alto Site



Site Location

El Leoncito Site